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INSECT PESTS OF ELMS IN CONNECTICUT

W. E. Britton and R. B. Friend

Connecticut
Agricultural Experiment Station
New Haven

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INSECT PESTS OF ELMS IN CONNECTICUT

W. E. Britton and R. B. Friend

Because of the Dutch elm disease that threatens the very existence of the beautiful elm shade trees of Connecticut and the other eastern states, there is an awakened interest in the welfare of the trees. Many inquiries and requests for information about elm trees are sent to the Station each week. This bulletin has been quickly prepared to answer such inquiries and to make available brief information concerning those insect pests of the elm tree as well as certain other conspicuous but less harmful insects that are likely to be noticed by property owners and men at work on this tree. It is hoped that it may be found useful.

Altogether, injurious insects are an important factor in tree decadence. There are insects that devour the foliage, insects that suck sap from the leaves and bark, and insects that are borers under the bark and in the wood. Heavy or partial defoliation of trees, as may be caused by canker worms or the elm leaf beetle, or both, seriously weakens the trees and renders them susceptible to the attack of bark beetles and borers. Hence it is important that all choice elm shade trees be sprayed to protect the foliage.

The Dutch elm disease is not an insect but a fungus. But this fungus is known to be carried from tree to tree by certain species of bark beetles that infest the elm. These bark beetles, like some other borers and certain fungous diseases, are prone to infest weakened and dying trees and branches, and knowledge of their life histories and habits is of much value in controlling the Dutch elm disease.

But neither insects nor fungi are responsible for all unthrifty trees. Some of the more common causes are:

Insects	Lack of plant food
Fungi	Poisonous gases
Lack of moisture	Mutilations

Tree specialists seem to agree that if the Dutch elm disease is to be eradicated, or even controlled, much will be gained by keeping the elms in a thrifty condition. Even if there were no Dutch elm disease, they should be given good care: pruned, sprayed, fertilized and watered when needed.

SPRAY MATERIALS AND APPLICATIONS

Arsenical Poison. The material most commonly used to protect trees from the ravages of leaf eating insects is lead arsenate. This poison

material has been used in many different proportions. In apple orchards the usual amount is three pounds to 100 gallons of water, but here it is important to control the insects without leaving a poison residue on the fruit at harvest time. On the other hand, for many years it has been the custom in gipsy moth control to use 25 pounds of poison in a 400 gallon tank, or 6.25 pounds in 100 gallons. Some commercial tree firms use even larger quantities, up to 8 or 10 pounds in 100 gallons. Although in the spraying of shade and woodland trees there is no fruit residue problem, perhaps such heavy doses are unnecessary. They are usually employed with a spreader, adherent or sticker added, to make certain of pest control in one application.

Certain kinds of tree foliage may be injured, or "burned", with such concentrated applications, either by the lead arsenate itself, or in combination with other materials. The addition of a suitable spreader will greatly reduce or prevent foliage injury. Where particularly tender foliage is concerned, it is advisable to use less lead arsenate.

Contact Spray. Several materials, particularly nicotine sulfate solution (40 per cent), rotenone or derris, and pyrethrum, are commonly used to kill certain insects by contact. They are used generally to kill sucking insects such as aphids and scales. Rotenone preparations are also stomach poisons. In heavy canker worm infestations, where the young caterpillars eat the leaf tissue as fast as it forms, it is difficult to kill them with lead arsenate alone. Consequently, it seems advisable to include a contact spray, which undoubtedly will kill some of the young caterpillars. For this purpose probably nicotine solution will be as satisfactory as anything. It is easier to obtain than the others and perhaps less expensive.

To kill certain sucking insects, it may be advisable to spray with a contact spray without the lead arsenate, but in most elm tree spraying operations a combination with suitable spreader will be satisfactory.

Spreaders and Stickers. Several materials have been used for this purpose, including skim milk powder, caseinate of lime, and small quantities of various kinds of oil. The skim milk powder and caseinate of lime act not only as spreaders but also prevent or delay certain chemical reactions between the other materials in combination sprays, that might otherwise result in foliage injury. Skim milk powder also acts as a sticker.

The oils act as stickers but are not of great value as spreaders, nor do they prevent chemical changes in the spray mixture. Fish oil is used as a sticker in the gipsy moth spray. It is cheap and effective, but some property owners object to its use, particularly on trees near the residence, because of the strong fish-oil odor. This odor disappears a few hours after application. Near residences it is better to use skim milk powder or linseed oil, but on roadside or woodland trees some distance away from human habitations, fish oil may be used.

General Spray Formula. In this bulletin it has seemed best to simplify spray procedure as much as possible. The following quantities of materials will meet the needs of a general spray for elm trees in most cases:

Lead arsenate	3 to 5 lbs.
Nicotine (40 per cent) solution	1 pint
Skim milk powder	1 lb.
Water	100 gals.

For the first canker worm spray, and in other cases where particularly tender foliage is involved, it will be safer to use only three pounds of lead arsenate. But five pounds should be used against the elm leaf beetle, gipsy moth and other insects that devour the mature leaves. When desired, one quart of fish oil or one quart of linseed oil may be substituted for the skim milk powder.

Bordeaux mixture may be combined with the other materials in this spray if a fungicide is needed.

Caution. Soap in any form should not be mixed with lead arsenate.

Key to Insects and Tree Injury

DEVOURING THE LEAVES

Looping caterpillars

Smaller: Green, brown or gray (.75 in.). May. Canker worms, page 269

Larger: Yellow with crinkled black dorsal lines (1.5 in.). May. Lime-tree looper, p. 272

Brownish-black with irregular yellow markings (2 in.). May. Snow-white linden moth, p. 273

Non-looping caterpillars

Black: Bearing branched spines, red spots on back (2 in.). Feeding in clusters. May and June. Spiny elm caterpillar, p. 274

Brown or gray: Hairy, 5 pairs blue and 6 pairs red spots on back (2.5 in.). May and June. Gipsy moth, p. 277

Reddish-brown: Hairy, 2 broken white stripes (1.5 in.). May and June. Brown-tail moth, p. 279

Yellow or grayish: Dark-striped with 4 upright white tufts on back, 2 pencils of long black hairs on head and one at tail (1.75 in.). May, June, August, September. White-marked tussock moth, p. 274

Brownish: Hairy, in white nests at ends of branches (1.5 in.). August and September. Fall webworm, p. 281

Cream color: Smooth, with black stripe along back (1.5 in.). Elm sawfly, p. 284

Larger: Rough, non-hairy, with 4 horn-like projections back of head, sharp pointed horn-like appendage near posterior extremity (3 in.). September. Four-horned sphinx, p. 283

Minute: Larvae mining in leaves forming irregular transparent blotch mines between the veins. June. Elm leaf miner, p. 283

Beetles

Yellow-olive green beetles (.25 in.), perforate leaves; yellow-black larvae feed on under side (.5 in.). May, June. Elm leaf beetle, p. 285

Green or blue beetles (.2 in.), perforate leaves; black larvae feed on under side (.5 in.). May, June. Elm flea beetle, p. 287

Bright shiny green beetles, copper wing covers (.5 in). July. Japanese beetle, p. 287

Other occasional leaf feeders p. 288

SUCKING SAP FROM LEAVES AND BARK

On leaves

Small green aphids on under side of leaves. Elm leaf aphid, *Myzocallis ulmifolii*, p. 289

Large gray aphid on twigs. Twig aphid, p. 289
Woolly aphids in flocculent masses on bark. *Eriosoma rileyi*, p. 291
Woolly aphids deforming the leaves
Crested projection on upper surface. Cockscomb gall aphid, p. 290
Rosette-like deformation. *Eriosoma lanigera*, p. 290
Leaf roll. *Eriosoma americana*, p. 290
Pouch shaped gall. *Eriosoma lanuginosa*, p. 291
Body flattened with whitish, transparent, ornate wings, on leaves (.12 in.). Elm lacebug, p. 291

On bark

Beechnut-shaped, green tree hopper, oviposits in twigs (.4 in.). Buffalo tree hopper, p. 294
Whitish, pear-shaped scales on bark of small twigs. Elm scurfy scale, p. 293
Brown, irregular, elongated pear-shaped scale, on twigs and branches. Oyster-shell scale, p. 292
Circular scales under edges of rough bark. Elm aspidiotus, p. 293
Oval, brown scales, with white fringed margins, in crevices of bark of trunk and larger branches. European elm scale, p. 294
Oval, light brown, convex scales, without white marginal fringe. European fruit lecanium, p. 293

Other sucking insects p. 296

BORING UNDER THE BARK

Bark beetles

Adult tunnel with the grain of the wood (vertical), one to two inches long; larval tunnels start across the grain. Beetle one-eighth inch long with reddish brown wing covers. Small European elm bark beetle, p. 296
Adult tunnel across the grain of the wood (horizontal) or at an angle, one to two inches long; larval tunnels start along the grain. Beetle one-eighth inch long with dark brown wing covers. Dark native elm bark beetle, p. 298
Irregular larval tunnels not over one and one-half inches long coming from a common center; no adult tunnel present. Elm bark weevils, p. 299
Winding broad tunnels packed with frass; larvae cylindrical, slightly over one inch long when fully grown. Elm borer, p. 300

BORING IN TWIGS AND BRANCHES

Borers

White, pink or yellowish caterpillar spotted with black, two inches long when fully grown. Leopard moth, p. 302
White beetle larvae, cylindrical, about an inch long when fully grown, in girdled twigs. Twig girdlers, p. 304

BORING IN ELM WOOD

Borers

White grub with prominent spine at posterior end, about two inches long when fully grown. Pigeon tremex, p. 305
White cylindrical grubs with body somewhat constricted near posterior end, tunnels packed with frass. Banded and red hardwood borers, p. 306

Occasional borers in elm bark and wood p. 307

INSECTS THAT DEVOUR THE LEAVES

Canker Worms

Next to the elm leaf beetle in importance as a leaf feeding pest are the canker worms, native to America, and seasonally the first to be considered. Canker worms are slender loopers, "inch worms", or "measuring worms", that spin downward on silken threads when disturbed. They feed upon the leaves in May and often defoliate deciduous trees and shrubs. Nearly all kinds of fruit, shade and woodland trees are subject to infestation and injury.

Usually canker worms are not uniformly injurious throughout the state, but locally are abundant and destructive. Thus in certain areas trees may be severely injured, while in other localities not far distant, canker worm injury is not noticeable. Damage from canker worms seems to be more common in the towns near the coast than in the northern or inland portion of the state. However, damage may occur in certain localities in one season and in other localities the following year.

In 1934 there was considerable defoliation of trees in Fairfield, New Haven and Middlesex counties, and some in New London County. From the great abundance of egg-clusters now on the trees, it is probable that extensive defoliation will take place in 1935, unless prevented by spraying.

There are two kinds of canker worms in Connecticut. One is called the fall canker worm because the eggs are laid in November and December; and the other is known as the spring canker worm, because the eggs are laid in March. The fall canker worm is far more common and is responsible for most of the damage. However, both kinds cause the same type of injury and are often found together feeding on the same tree.

Fall Canker Worm, *Alsophila pometaria* Harr. The gray moths emerge from the ground on the warm days of November and December. The males have wings and may be seen flying about near the ground around the trunks of trees or resting on the bark. They are attracted to automobile headlights and other lights placed near the ground. The females are wingless and must crawl up the trunks to reach the branches. They lay eggs in compact clusters on the bark of twigs and branches, each cluster averaging about 100 eggs. The eggs are grayish brown cylinders set closely side by side and attached by one end to the bark. The top of each is nearly flat but with rounded margins. In the center is a circular lid, or cover, that comes off when the eggs hatch.

The female is gray with brown scales intermixed, and the length of the head, thorax, and body together is about three-eighths of an inch. The two-jointed ovipositor may be exserted. The male has a wing spread of about an inch, or slightly more, and is brownish-gray with a lighter spot on the front margin of each forewing about two-thirds the distance from base to apex.

Depending on the weather, the eggs hatch the latter part of April or the first few days of May and the young caterpillars commence to feed upon the tender unfolding leaves. They eat holes through the leaves and may devour all the leaf tissue except the veins. As the leaves become firmer and reach maturity, the caterpillars often leave a greater portion of the network which turns brown. An injured elm leaf and caterpillars are shown in Figure 34.

Of the caterpillars hatching from an egg-cluster, some are pale green, some are dark gray and some are brown or nearly black, and all are striped longitudinally with thin, whitish lines. These caterpillars have three pairs of false legs or pro-legs, the front pair on the eighth segment being smaller than the others. When fully grown, they are three-fourths or seven-eighths of an inch in length.

In most seasons the caterpillars reach maturity by the end of the first week in June, and go into the ground to pupate. They spin silk threads that hold together particles of soil to form a cocoon which is not easily crushed. The pupa is dark brown, one-third of an inch or less in length, with apex rather blunt and with apical spine decurved and always forked. The adults emerge on the warm foggy days of November and December.

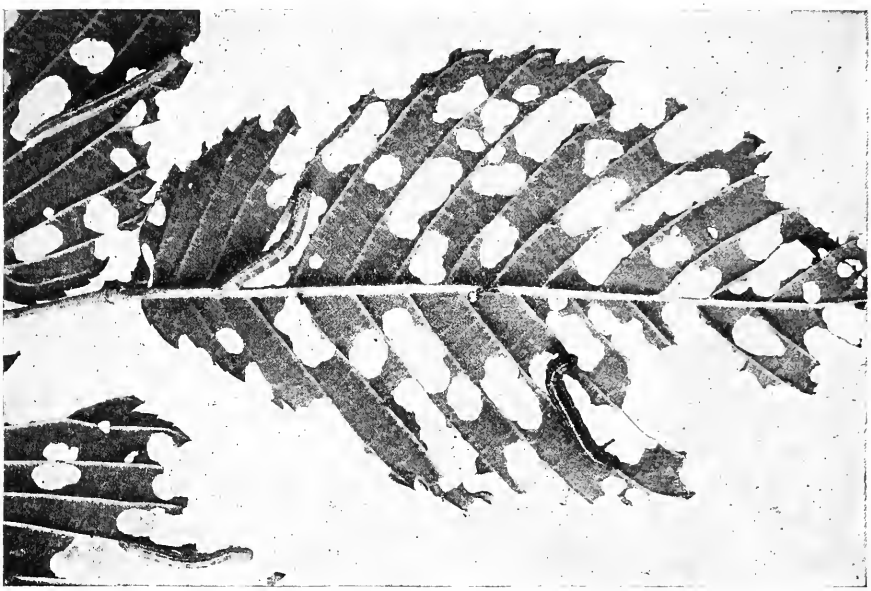

FIGURE 34. Appearance of canker worms feeding on elm leaf. Natural size.

The eggs, larvae, male and female moths, and elm leaf injured by the caterpillars are shown in Figure 35.

Spring Canker Worm, *Paleacrita vernata* Peck. In March the light brown, oval eggs of this species are usually laid in loose, irregular clusters, averaging 47 eggs each, in the crevices of the rough bark. The shells are much thinner than those of the fall canker worm, and hatch at about the same time. The caterpillars are dark gray or brown, striped longitudinally with narrow, pale lines. Although they often feed together with the fall canker worm, they may be distinguished from it by the absence of pro-legs on the eighth segment, making two pairs of pro-legs instead of three.

The female is gray with a rather broad, black or dark brown stripe, lengthwise on the back. It is somewhat shorter and more hairy than the fall canker worm and it is also wingless. The two-jointed ovipositor is

rather conspicuous when exserted. The male has brownish gray, semi-transparent wings, with spread of about one inch, and without prominent markings.

The pupa is light brown, one-third of an inch or less in length, somewhat more slender than the fall species, and with apex more sharply pointed. The apical spine of the male is usually simple. The pupal cells contain only

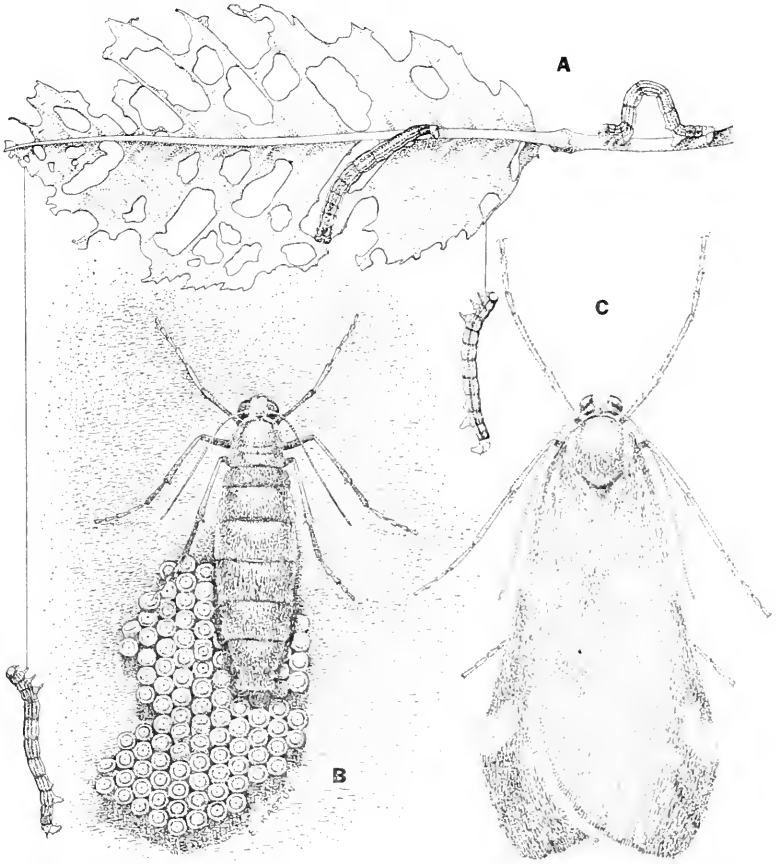

FIGURE 35. Eggs, larvae, male and female moths of the fall canker worm, and elm leaf injured by the caterpillars. A, leaf and full grown caterpillars about natural size; B, eggs and female moth; C, male moth; both insects about five times enlarged.

a few threads of silk and are less firm and more easily broken than those of the fall canker worm. The adults emerge from the ground in March.

Control of Canker Worms. Spraying. Probably in general, and particularly in the coming season, the best means of control is to spray with lead arsenate about the middle of May, or earlier, if the leaves have developed sufficiently to catch and hold the poison. If the application is made at too early a date, the leaves that form after the spray was applied will not

be poisoned and may be devoured. On the other hand, severe damage should not be allowed to occur before the trees are sprayed. In some cases where canker worms are very abundant, the young leaves are devoured as fast as they develop, and at no time is there any leaf growth to poison. In such cases it is advisable to spray with, or add to the lead arsenate, a contact insecticide like rotenone, derris, pyrethrum or nicotine sulfate solution.

Use of Sticky Bands. Isolated trees can usually be protected by placing bands of Tree Tanglefoot around the trunks late in October. Kept sticky during November and December, these will prevent the females from ascending the trees to lay eggs, and again during March, April and May, they will keep the young caterpillars from crawling up. The sticky material may be applied directly to the bark, but it will disfigure the trees and the writers do not recommend this method.

Several years ago, methods of banding were developed at this Station by which the bands may be removed at the end of the caterpillar season leaving no disfiguration. This method is as follows: Place a two-inch strip of cheap cotton batting around the trunk to fill the crevices and prevent the caterpillars from crawling under the band. Over the cotton batting, draw tightly a four- or five-inch strip of single ply tarred paper and tack into the tree where the ends lap. Over the upper half of the band smear a quarter-inch deep layer of Tree Tanglefoot. This can readily be applied with a wooden paddle, having a thin blade about two inches wide, such as can be made easily from an old shingle. A similar paddle with sharp deep notches cut across the end of the blade, makes a convenient tool for combing or stirring the Tanglefoot when it becomes hardened on the surface or stuck full of leaves or male moths. The bands may need combing once or twice in late fall and once or twice in spring to prevent the insects from crawling over them. There is usually some feeding on trees where the bands have been applied at the right time and given proper attention, due to drift of caterpillars by the wind, but there should be no severe injury.

The manufacturers of Tree Tanglefoot now make and sell banding strips which may be removed without disfiguring the trees.

Lime-Tree Looper

Erannis tiliaria Harr.

This native insect, often called the lime-tree winter moth, or lime-tree span worm, feeds upon the foliage of apple, pear, linden, birch, hickory, elm, oak and probably other woodland trees. Usually it is not very common in Connecticut but there is an occasional outbreak when trees are defoliated. There is only one generation each year. The female is wingless and lays eggs singly or in loose clusters on the bark in October and November. These eggs hatch in late April or early May and the caterpillars feed upon the expanding leaves, as canker worms do, and are often found feeding in association with them. Lime-tree loopers reach maturity early in June and pupate in cells in the ground. The adults emerge in the fall in Connecticut.

The mature caterpillar is about one and one-half inches in length, bright yellow, with rust-brown head, and 10 crinkled black lines extending lengthwise along the back. There is wide color variation; some caterpillars, dorsally, are almost black and others are distinctly light-colored. The males have a wing expanse of about one and three-fourths inches and are buff, marked transversely with two wavy brown bands and sprinkled with small, brownish dots. The female is wingless, greenish-yellow varying to light gray or brown, with two rows of black spots lengthwise of the back, and about half an inch in length. The larva is shown in Figure 36 and the female in Figure 37.

Control. Spraying with lead arsenate, as recommended for canker worms, will control this insect.

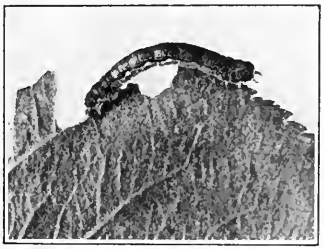

FIGURE 36. Caterpillar of the lime-tree looper. Natural size.

FIGURE 37. The lime-tree looper. Female. Twice natural size.

Snow-White Linden Moth or Elm Span Worm

Ennomos subsignarius Hubn.

Fifty or more years ago this insect was considered an important pest of various shade trees, including elm, particularly in Brooklyn, New York and Philadelphia. Since then it has been much less abundant and now is only occasionally reported as injuring trees. However, there was an outbreak of this insect in New York State in 1907, continuing each year into 1910, when large woodland areas in the Catskill and Adirondack Mountains and in other places were defoliated. In 1908 and 1909 extensive flights of the white moths occurred in July in the vicinity of New York City, in the Hudson River Valley and other sections. The moths were very numerous around electric lights in New Haven, July 19, 1908, and continued for two days. Then they disappeared.

This insect has one generation each year and the light brown eggs are deposited in midsummer in irregular clusters on the bark. The eggs hatch when the leaves first unfold and the caterpillars reach maturity late in June. They are about two inches in length, brownish black, with irregular yellowish markings, and closely resemble elm twigs. The yellowish brown cocoons occur among the leaves. The moths have a wing

spread of about one and one-half inches, and are pure white with angulated wings.

Control. Spraying with lead arsenate is the proper remedy.

Spiny Elm Caterpillar

Hamadryas antiopa Linn.

Clusters of black, spiny caterpillars are often seen feeding on elm, poplar and willow, sometimes stripping the branches. The yellow eggs are laid the first half of May in naked, cylindrical clusters of about 300 each around the small twigs. These eggs hatch in two weeks, and the young caterpillars feed together side by side with heads toward the margin of the leaf, eating away the green tissue and leaving only the veins. As they reach maturity near the end of June, they devour everything except the mid-veins. They are then about two inches in length, ground color black, with small white dots arranged in transverse rows giving the caterpillar a hoary or grayish appearance. Along the back is a row of red spots, roughly diamond shape. Each segment bears transverse rows of black, branched spines.

During this feeding period they molt, or cast their skins, four times. They then cease feeding, scatter, attach themselves to the under side of a branch or fence rail, and again molt, and the cast skin becomes the cocoon. In about two weeks the adult emerges as a large, purplish brown butterfly with yellow wing margins, a submarginal row of pale blue spots, and a wing spread of about three inches, called the "mourning cloak." This butterfly lives over winter and may be seen flying about in woodlands on warm days in February.

There are two generations of this insect annually. The first brood caterpillars feed in late May and June, and the second brood in late July and August. The caterpillar, cocoon and adult butterfly are shown in Figure 38.

Control. On small trees the egg-clusters or clusters of caterpillars may be clipped off and destroyed. An arsenical spray, such as is recommended for the control of canker worms and the elm leaf beetle, will also prevent injury by the spiny elm caterpillar.

White-Marked Tussock Moth

Hemerocampa leucostigma S. & A.

The caterpillars of the white-marked tussock moth have caused severe defoliation of deciduous shade trees at various times in the cities of Albany, Baltimore, Boston, New Haven, New York, Philadelphia, Providence, Washington and other cities where outbreaks have occurred. This native insect is usually a much greater pest in cities and villages than in the open country. It occurs from Nova Scotia to Florida and as far west as Nebraska, but is the most troublesome in southern New England

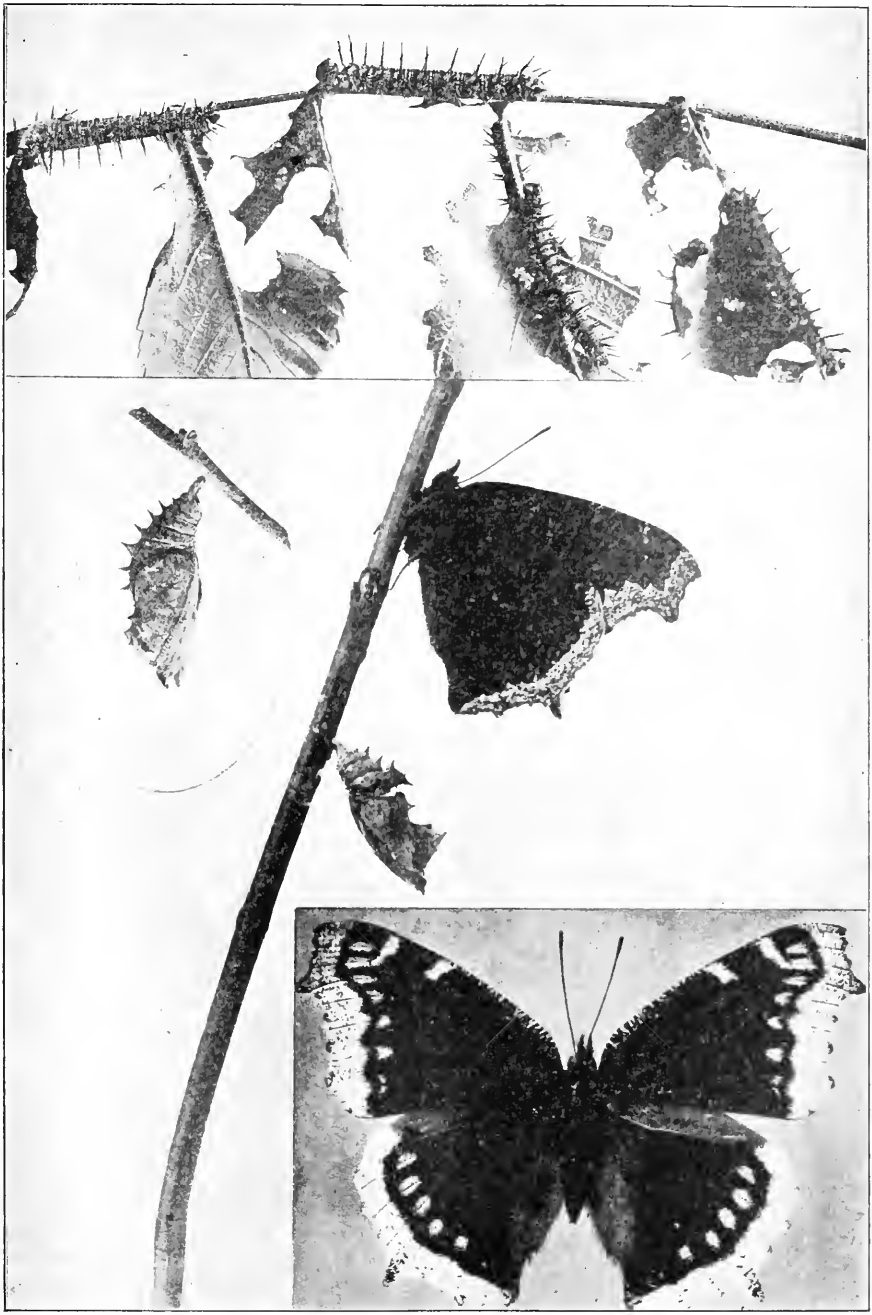

FIGURE 38. The spiny elm caterpillar, or mourning cloak butterfly; caterpillars, chrysalis and adults. All natural size.

and the Middle Atlantic States. Poplar, elm, linden, soft maple and horse-chestnut seem to be the preferred food plants, but it will feed upon nearly all kinds of fruit, shade and forest trees and shrubs, except conifers.

There are two generations annually in Connecticut, only one at Albany, N. Y., and at least three at Washington, D. C. The insect passes the winter in the egg stage. The eggs hatch in May and the young caterpillars feed upon the under side of the leaves, eating only the green tissue of the lower side and leaving the veins and upper epidermis. As the caterpillars become larger, they eat entirely through the leaf blades and finally devour all except the largest veins. In about five weeks the caterpillars become mature and spin some threads which, mixed with the hairs from their bodies, form gray cocoons that are usually placed on the rough bark of trunk or branches, but sometimes on twigs and leaves. Two weeks later the adults emerge. The male is a gray moth that flies around lights at night. The female has no wings and can crawl only

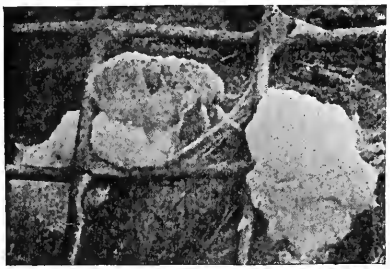

FIGURE 39. Female, old cocoon and egg-mass of the white-marked tussock moth. Natural size.

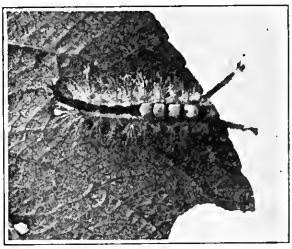

FIGURE 40. Caterpillar of the white-marked tussock moth feeding on apple leaf. Natural size.

short distances. She usually lays from 100 to 500 eggs in a white, frothy mass on the old cocoon. These eggs hatch in July and the caterpillars feed during August and into September, when they reach maturity and pupate. The female, old cocoon, and white egg-cluster are shown in Figure 39.

The full grown caterpillar is about one and three-fourths of an inch in length, yellowish gray, with a dark brown or black stripe along the back, bright red head, and four white or yellow upright tufts of hairs back of the head. Two diverging pencils of black hairs project forward from the thorax and a similar one projects backward from the posterior extremity. The appearance of the caterpillar is shown in Figure 40.

Control. Although the female is wingless and cannot fly, sticky bands are useless as a measure of control because the female moths do not emerge from the ground and crawl up the trunk. They or their egg-clusters are already in the trees. Spraying the foliage with lead arsenate is perhaps the best means of control.

Gipsy Moth

Porthetria dispar Linn.

The gipsy moth is an European insect that has caused damage in the New England States for about 50 years, and enormous sums of money have been expended by the Federal Government, the various state governments, and by property owners to check it and prevent its spread to other parts of the country. The gipsy moth caterpillars feed upon a very large number of trees and shrubs and among them is the elm.

The gipsy moth has one annual generation. The eggs are laid in July on the bark of the trees or in cavities, and on rocks, fences, and the like. It is in the egg stage that the insect lives through the winter, and the eggs hatch about May 1. The caterpillars feed for a period of about six weeks and devour the entire leaf blades. Soon after the middle of

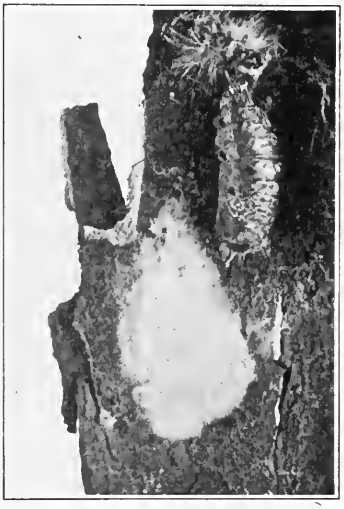

FIGURE 41. Gipsy moth egg-cluster and pupa on the under side of hickory bark. Natural size.

June they begin to pupate in cavities and protected corners. The pupa has a few silk threads to hold it in place, but is not covered by a cocoon. From 10 to 14 days are spent in this stage, when the adult emerges. The female cannot fly but the male flies about freely even in the daytime.

The egg is spherical, whitish or transparent, and one millimeter or slightly more in diameter. The eggs are laid in compact clusters averaging 400 or more eggs in each, and covered with buff hairs from the body of the moth. The clusters vary widely in size and shape, but roughly speaking they are oval, about two-thirds as broad as long, and in color and texture resemble a piece of chamois skin. Occasionally an egg-cluster may be two inches in length, some not more than half an inch, but the average length seems to be about one inch. The egg-cluster and pupa are shown in Figure 41.

The caterpillars are gray or brown and, when fully grown, vary from two to three inches in length. The larger ones develop into females.

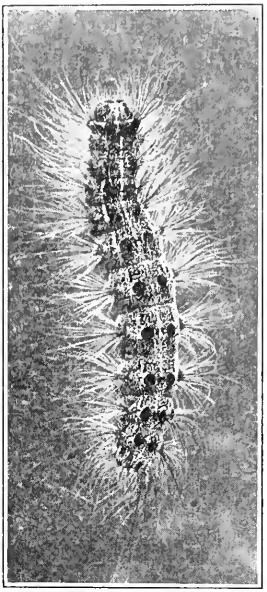

FIGURE 42. Gipsy moth caterpillar. Natural size.

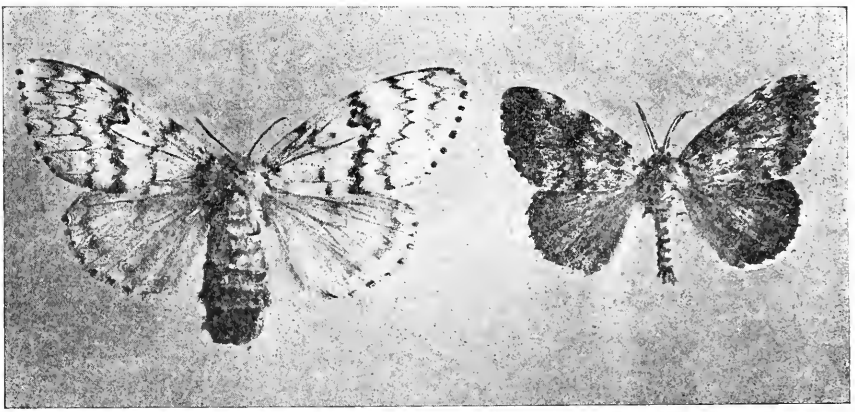

FIGURE 43. Female and male gipsy moths. Natural size.

There is a narrow, longitudinal, lighter stripe along the back, with a row of tubercles on either side of it, two on each segment. From the head, the first five pairs of tubercles are blue, and the six remaining pairs are brick red. Each segment bears six tubercles arranged in a transverse

row, and each tubercle bears a tuft of light and dark brown hairs. The caterpillar is shown in Figure 42.

The pupa is almost naked but is loosely fastened by a few strands of silk, and is reddish-brown, with light brown hairs around the spiracles and across the segments. It is fastened by the apical segment which also bears a tuft of light brown hairs. The pupae usually occur in clusters in protected places such as in cavities, crotches of trees and under horizontal branches and fence rails.

The sexes are quite different. The female is a dirty, creamy white with rather faint, transverse, scalloped markings on the forewings, and with a wing spread of two or more inches. The abdomen is heavy, cylindrical, and covered with buff hairs. The male is smaller, with pointed abdomen, and a wing spread of about one and one-half inches. The color varies from light brown to dark brown. Both sexes are shown in Figure 43.

Control. The control measures commonly practiced are scouting for egg-clusters and soaking them with creosote during the winter months, and spraying the infested trees with lead arsenate, 5 pounds in 100 gallons of water, in late May and in June.

Brown-Tail Moth

Nygmia phaeorrhoea Don.

The brown-tail moth of Europe appeared in the New England States near Boston in 1897. It was first discovered in Connecticut in 1910, and spread rapidly until it covered the eastern half of the state. Then climatic conditions, natural enemies, or both, caused it to decrease and disappear. Not a single winter nest has been observed or reported in Connecticut since 1919, yet the pest has persisted in northeastern Massachusetts and may again appear in Connecticut. The caterpillars feed upon a large number of deciduous trees but seem to prefer pear, apple, the stone fruits, oaks, maples and elms.

The moths appear during the first half of July, and the females lay elongated egg-masses containing from 200 to 400 eggs each on the under side of leaves. The eggs hatch in about three weeks, or around the first of August, and the young caterpillars at first feed on the leaf bearing the egg-masses, causing it to turn brown. Later they go to other leaves and feed until September, when they form their winter nests. They draw together some old leaves and enclose them with woven silk, covering their petioles, fastening them to the twig so that the nest cannot be torn away. These nests are usually on the terminal twigs. A number of caterpillars, probably all survivors that hatched from an egg-mass, crowd into the same nest and there pass the winter.

On the warm days of April, the caterpillars leave the nest and feed upon the opening buds. They molt three and sometimes four times, and reach maturity about the middle of June. Each caterpillar then makes its cocoon by fastening together a few leaves with silk threads, and pupates within the cocoon. It is not uncommon to find several pupae

in the same bunch of leaves. From 15 to 29 days are passed in this stage, when the adults emerge, usually during the first half of July. Both sexes fly and are strongly attracted to lights.

The caterpillars are not only a pest of trees but are a nuisance to human beings. The short barbed hairs of the red dorsal tubercles of the ninth and tenth segments are poisonous and cause an intense irritation, or rash, wherever they come in contact with the human skin. These hairs

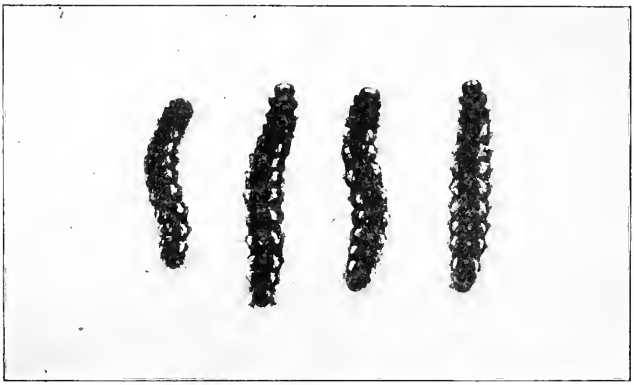

FIGURE 44. Caterpillars of the brown-tail moth. Natural size.

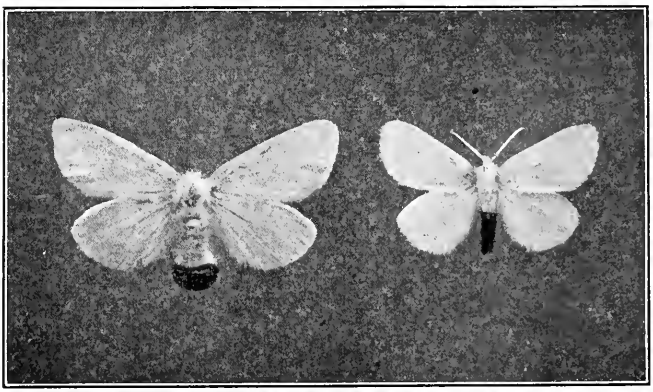

FIGURE 45. Female and male brown-tail moths. Natural size.

are brittle. They are broken off and blown around, and it is almost impossible to avoid them in a region infested by the brown-tail moth.

Both sexes are pure white with brown hairs on the end of the abdomen. The female is the larger, with wing spread of one and one-half inches; wing spread of the male is about one and one-eighth inches. The egg-masses are reddish brown and vary greatly in size and shape. Usually they are from half to three-fourths of an inch long and perhaps one-fourth

of an inch broad. The fully grown caterpillar is reddish brown with light brown hairs. Beginning with the fourth segment, each segment bears a pair of tufts of white hairs, one on each side. These tufts show both dorsally and laterally, and from above appear as two broken white stripes. On each of the ninth and tenth segments, on the back, is a small, coral red tubercle bearing short barbed, poisonous hairs. In length, the caterpillar is from one and one-fourth to one and one-half inches. The naked pupa is dark brown and about half an inch in length. The caterpillars are shown in Figure 44, the adults in Figure 45, and the winter nests in Figure 46.

Control. The usual control measures consist of clipping off and burning the nests in winter, in spraying the foliage of infested trees with

FIGURE 46. Winter nests of the brown-tail moth on pear. Much reduced.

lead arsenate in August to kill the young caterpillars, and in spraying about the middle of May to kill the larger caterpillars, in case they are present in destructive numbers.

Fall Webworm

Hyphantria cunea Drury.

This native insect is a general feeder and makes nests on the ends of the branches of all kinds of deciduous trees in late summer. It is partially double-brooded in Connecticut, and the caterpillars in the early nests may develop a second generation. The great majority of nests are formed in August and September and the insects in such nests are

single-brooded. These nests are prevalent throughout the state every year and are particularly conspicuous in the northern portion. Many trees are stripped of foliage, and perhaps every terminal branch will bear one or more of the unsightly nests.

The eggs are laid in greenish-white clusters on the under side of a leaf, each cluster containing from 400 to 500 eggs. The eggs hatch in 10 days and the caterpillars feed together inside a nest on the same branch. They spin silk threads, draw together a bunch of leaves and feed on this foliage. When this food becomes exhausted, they extend the nest to include additional foliage. They mature in about six weeks and pupate in light brown cocoons under rubbish or attached to fence rails and tree trunks, where they pass the winter.

FIGURE 47. Nests of the fall webworm on woodland trees. (After Slingerland).

The egg is spherical, with surface finely pitted or sculptured, and about 0.55 mm. in diameter. When first hatched, the caterpillar is pale yellow with two rows of dark tubercles bearing hairs along the back. When full grown, it is from one and one-fourth to one and one-half inches in length, and in color may be solid brown, nearly black, or gray, with two rows of black and orange tubercles along the back, bearing a mixture of white, light brown and black hairs, nearly uniform in length. The pupa is brown, less than half an inch in length, and enclosed in a thin gray cocoon in which larval hairs and particles of dirt are mixed. The moths of both sexes are either pure white or more or less well-marked with black dots. The nests are shown in Figure 47.

Control. Where the nests are within reach, they can be clipped off when small, and burned. The insect cannot feed on trees that have been sprayed with lead arsenate, so there will be no unsightly nests.

Four-Horned Sphinx

Ceratomia amyntor Hubn. (*quadricornis*)

This native insect is not an important elm pest but the caterpillar is conspicuous and may often be seen in September. It reaches a length of three inches, and may be pale green, flesh color, or reddish brown, with surface roughened or papilliferous, but not hairy. There are four, fleshy, horn-like appendages on the thorax, and a conspicuous caudal horn. There is one annual generation, and the winter is passed by the pupa in the soil. The adult moth is one of the sphinx, hawk, or hummingbird moths, with forewings light brown, streaked with dark brown or black, and with wing spread of about four and one-fourth inches. The caterpillar is shown in Figure 48.

FIGURE 48. The four-horned sphinx caterpillar. Natural size.

Control. Special treatment is unnecessary, and lead arsenate spray for other leaf eating insects will hold it in check.

Elm Leaf Miner

Kaliofenusa ulmi Lund.

This introduced insect is a sawfly, and the larva is a leaf miner that works between the upper and lower epidermal layers of a leaf, usually between two lateral veins. Several miners often occur in the same leaf, with the result that the entire leaf is a transparent blister and all green tissue is destroyed. This is more particularly a pest of Scotch and English elms, but American elms are also injured. The adult is a small, black, four-winged fly with wing spread of about one-third of an inch, that inserts its eggs in the upper side of the leaf the latter part of May. The larvae mine the leaves during June, and by the first of July reach maturity and go into the ground, where they spend the winter and pupate in

the spring. There is one brood each season. Injured leaves are shown in Figure 49.

Control. The miners may be killed by a spray of nicotine solution used at the rate of one pint in 100 gallons of water, either with or without a spreader. The spray should be applied when the mines are first noticed, usually near the first of June.

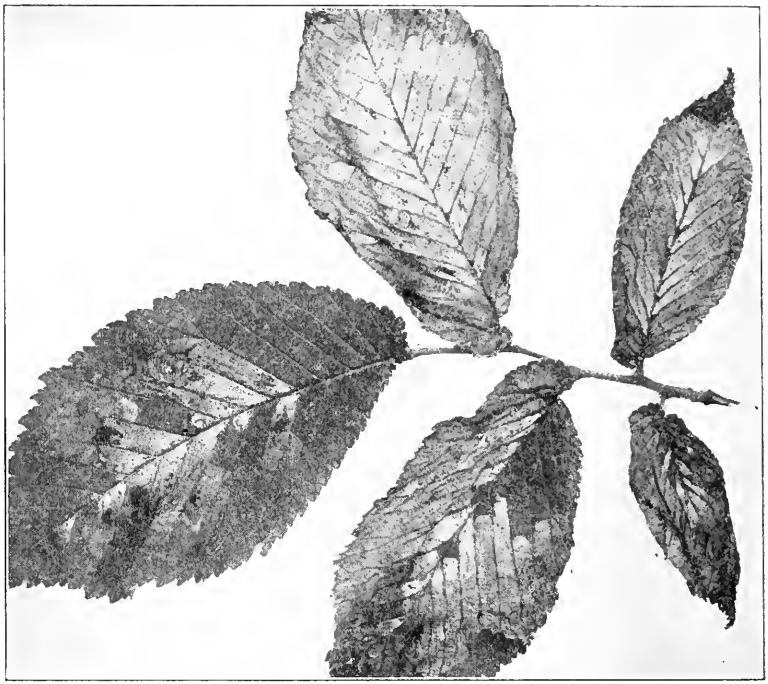

FIGURE 49. Characteristic injury of elm leaf miner. Somewhat reduced.

Elm Sawfly

Cimbex americana Leach.

Frequently cream-colored larvae, each with a longitudinal black stripe along the back and about one and one-half inches in length, may be found feeding upon the elm leaves or coiled up like a snail shell between the edges of rough bark, as shown in Figure 50.

This native insect is never sufficiently abundant in Connecticut to be considered as an important pest, but because of its striking appearance, is included here. The adult is one of our largest sawflies, with wing spread of nearly two inches. There is only one generation each year.

Control. If control measures are needed, the poison spray used against the elm leaf beetle should suffice.

Elm Leaf Beetle

Galerucella luteola Müll.

Probably the most widely destructive leaf feeder on elm in Connecticut is the elm leaf beetle introduced from Europe. It is chiefly destructive to elm trees in cities and villages, and although trees in the open country are sometimes defoliated, as a rule they are much less severely injured.

The elm leaf beetle has one complete generation and a partial second generation in Connecticut. The adult beetles hibernate in the attics of buildings, towers of public buildings, belfries of churches, cracks and crevices of posts, fences, telephone poles, under loose bark and in other similar places where they can find suitable protection.

They emerge on the warm days of spring, fly into the trees when the leaves first unfold, and eat holes through the tender foliage. After mating, the females lay oval yellow eggs in clusters on the under side of the leaves, beginning late in May and continuing for about four weeks. In about a week the eggs hatch and the grubs, or larvae, feed upon the under

FIGURE 50. Larva of elm sawfly. Twice natural size.

surface of the leaves, eating off the green tissue in patches but leaving the veins and upper epidermis. When several or many feed upon the same leaf, a large portion or all of the green tissue is devoured, and later the leaf turns brown and falls. The larvae feed for about three weeks when they reach maturity. They crawl down the trunks and transform into bright, orange-yellow pupae on the surface of the ground around the base of the trunk or in the crevices of the rough bark. About 10 days later the adults emerge and fly away into the tree tops. There they do some feeding, and some of them lay eggs for a partial second brood, but many of them go into winter quarters early.

It is usually about the middle of July that the yellow pupae are most prevalent at the bases of the trees, and soon after, the injured leaves fall from the trees. If rain follows, new leaves soon appear. But all trees are weakened by the loss of a crop of leaves and it may happen that these same trees had lost the first leaves by canker worms. The loss of two crops of leaves in a season is a severe damage to trees.

The beetle is about one-fourth of an inch long, light yellow on emergence, with a dark, olive green stripe along the outer margin of each wing cover. It soon becomes darker and duller, and the over-

wintering beetles are dull olive green, with the dark stripes rather indistinct. The mature larva is about half an inch long. It is dull yellow and has a pair of longitudinal black stripes along the back, with a broad yellow stripe between them. There are two longitudinal rows of tubercles between the black stripes and two lateral rows of tubercles that are black and bear black hairs. The pupae are bright orange-yellow. The appear-

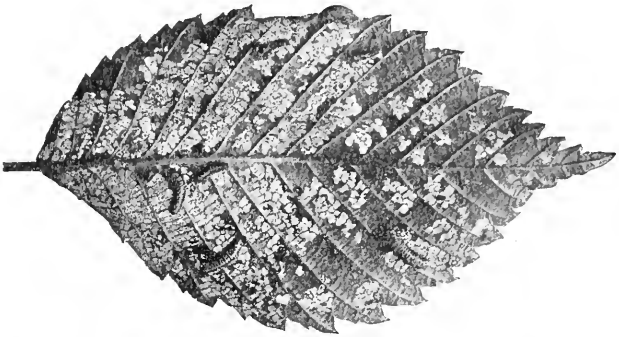

FIGURE 51. Elm leaf showing larvae of the elm leaf beetle and the damage they do by feeding on the under surface. Natural size.

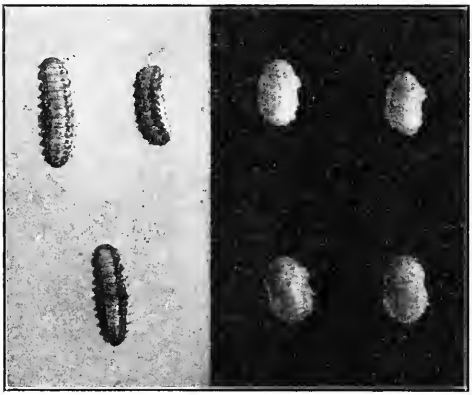

FIGURE 52. Larvae and pupae of the elm leaf beetle. Twice natural size.

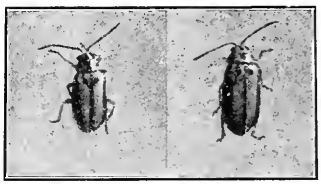

FIGURE 53. Adult elm leaf beetles. Twice natural size.

ance of an injured leaf and larvae are shown in Figure 51, larvae and pupae in Figure 52, and the adults in Figure 53.

If rainy weather occurs at the time of pupation, many of the pupae on the ground are infected and killed by a white mold or fungus.

Control. The best means of control is to spray thoroughly the under sides of the leaves early in June with lead arsenate at the rate of five pounds in 100 gallons of water, with a suitable spreader.

Elm Flea Beetle

Haltica ulmi Woods.

Occasionally, small, bright green or blue beetles are found in large numbers around the base of certain elm trees in spring. They are somewhat metallic or iridescent in appearance and are sometimes very abundant locally, but not usually destructive over wide areas. This insect has been mentioned in literature under several common names. At first it was thought to be identical with the strawberry flea beetle, *Haltica ignita*, and has been so recorded. It has also been called the "green elm beetle" and the "blue elm beetle".

The beetles begin feeding upon the new leaves soon after they unfold, and eat holes through them. The females lay eggs and the larvae feed upon the under side of the leaves in much the same manner as those of the elm leaf beetle. There is one generation each season, and the adult beetles live through the winter under the loose bark, under fences or debris at the base of the trees. The adult beetle is about one-fifth of an inch in length and is somewhat smaller than the elm leaf beetle. The larva is also smaller and is nearly black.

Control. The usual lead arsenate spray such as is applied for the elm leaf beetle will control this insect.

Japanese Beetle

Popillia japonica Newman.

This beetle is a native of Japan and first appeared in this country in New Jersey in 1916, whence it has spread into other states. It was first discovered in Connecticut in 1926 and is now present in all of the larger cities, and in villages in all sections of the state, although not yet sufficiently abundant to damage the trees. After the beetle population has had time to build up a sufficient degree of abundance, the Japanese beetle is almost certain to damage severely many kinds of fruit, shade and woodland trees, including elm. The writers have seen along streets in New Jersey in July, tall elm trees that had been almost completely defoliated by the adult Japanese beetles. They usually feed upon the tender leaves at the tips of the season's growth.

The eggs are laid in the ground in July, hatch in two weeks, and the grubs or larvae feed upon grass roots near the surface, going deeper on the approach of cold weather. In the spring they ascend to the surface early in May and feed for a short time, then become inactive and pupate in the soil in late May or early June. The adult beetles emerge from two to four weeks later, and are at their height of abundance about the middle of July.

The eggs are white, elliptical in shape, about one-sixteenth of an inch long and two-thirds as thick. They are laid singly from two to four inches below the surface, and each female deposits from 40 to 50 eggs. The larvae resemble common white grubs. The adult beetles are about half an inch long, with head, thorax, legs and abdomen bright, shiny

green and bronze or copper colored wing covers. Two tufts of hairs on the apex of the abdomen, and five smaller ones on each side near the apex, show beyond the wing covers, as indicated in Figure 54.

Control. The grubs in the soil may be killed by applying lead arsenate to the surface at the rate of three pounds to 100 square feet. Tree foliage may be protected by heavy spray applications of lead arsenate.

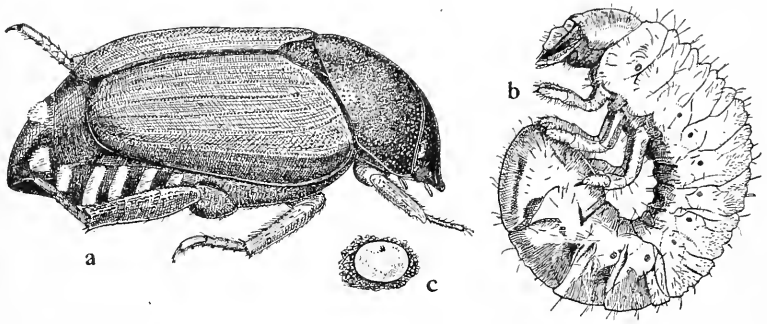

FIGURE 54. The Japanese beetle. A, Adult beetle; b, larva; c, egg. Each enlarged about five times.

Other Occasional Leaf Feeders

In addition to the leaf feeding insects described on the foregoing pages, certain other insects may be found occasionally feeding upon elm. Among them are the hickory tussock moth, *Halisidota caryae* Harr., and the tessellated tussock moth, *Halisidota tessellaris* S. & A., both hairy caterpillars with pencils of longer black hairs on thorax and at caudal extremity. The two-toothed prominent, *Nerice bidentata* Walk., feeds only on elm, and an occasional caterpillar may be noticed in midsummer. When full grown, it is one and one-half inches or slightly longer in length, leaf green in color, with a peculiar crest or wave-like forward-pointing projection on the dorsum of each abdominal segment. The caterpillars of two other moths, *Schizura ipomoeae* Doubl., and *Schizura unicornis* S. & A., feed occasionally upon elm.

Falcaria bilineata Pack., *Sisyrosca textula* H. S., *Tolype velleda* Stoll, the fruit tree leaf roller, *Cacoecia argyrospila* Walk., the io moth, *Automeris io* Fabr., the imperial moth, *Basilona imperalis* Drury, the polyphemus moth, *Telea polyphemus* Cram., the forest tent caterpillar, *Malacosoma disstria* Hubn., and the bagworm, *Thyridopteryx ephemeraeformis* Haw., have been recorded as feeding upon elm. Likewise, the hop merchant, or violet-tip butterfly, *Polygonia interrogationis* Fabr., is occasionally abundant and its brown spiny caterpillars sometimes devour elm leaves. The elm case bearer, *Coleophora limosipennella* Drury, the larvae of which are miners in the leaves, might be confused with the elm leaf miner, but may be distinguished from it by the presence of the tiny, cigar-shaped cases fastened by one end to the leaf and standing outward perpendicularly from it. (Figure 55).

Also certain other beetles, when abundant, feed on the leaves of various trees and may feed upon elm foliage. Some of these are the May or

June beetles, *Phyllophaga* sp., the rose chafer, *Macrodactylus subspinosus* Fabr., and the small Buprestid, *Brachys aerosa* Mels. Should they be present, probably any or all of these insects will be killed by the application of the poison spray.

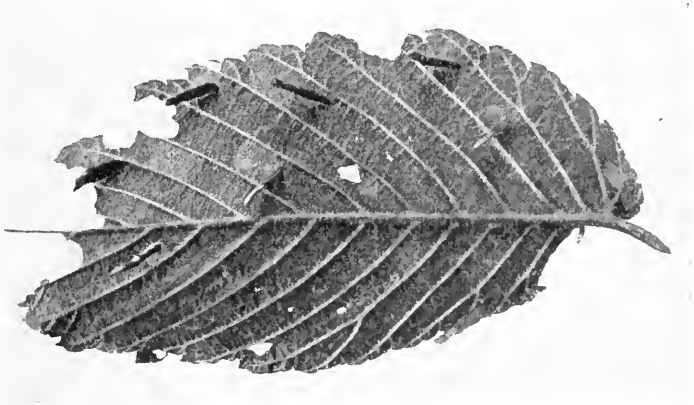

FIGURE 55. The elm case bearer. Natural size.

INSECTS THAT SUCK SAP FROM THE LEAVES AND BARK

Elm Leaf Aphid

Myzocallis ulmifolii Monell.

This is a pale, whitish-yellow aphid of small size, with body less than one-twelfth of an inch long. Spine-like tubercles are borne on the dorsum. Apparently this aphid is not common but may be found occasionally on the under side of elm leaves.

Control. Spray with nicotine sulfate solution.

Twig Aphid

Longistigma caryae Harr.

This is said to be the largest aphid occurring in the United States. It is usually found upon the bark of the twigs and branches of various species of deciduous shade and woodland trees. Our records show that it has been found on chestnut, elm, hickory, oak, sycamore, white birch and black walnut. The oval black eggs are occasionally seen on the twigs in winter and they are much larger than the eggs of other species of aphids. Little seems to be known about the life history of this aphid or its status as a pest. Presumably it is not very injurious.

The body of the twig aphid is about one-fourth of an inch in length, ash gray, with black spots on the thorax, two rows of black spots on the

dorsum and another row along each side of the abdomen. The cornicles are short and blunt or tuberculate.

Control. The nicotine sulfate spray should be effective against this aphid.

Woolly Aphids of Elm

The cockscomb gall aphids, *Colopha ulmicola* Fitch and *Tetraneura graminis* Monell, form crested excrescences on the upper side of the leaves. These galls are usually about an inch in length, one-fourth of an inch high with irregular crest, and situated between and parallel with

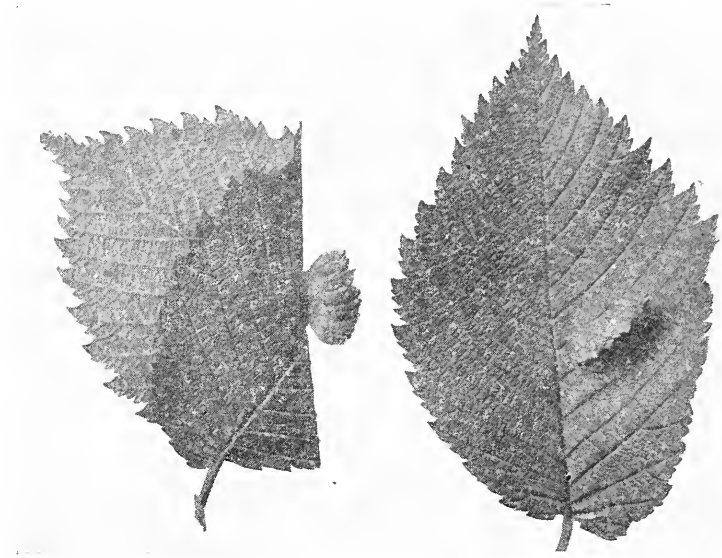

FIGURE 56. Gall of the cockscomb gall aphid, on elm. Natural size.

the lateral veins, as shown in Figure 56. The galls appear with the unfolding leaves, but later in the summer become empty and turn brown. The aphids live inside the galls and there is considerable wax secretion, giving them a mealy or woolly appearance. On leaving the elm leaves, both aphids migrate to the roots of grasses for the remainder of the summer.

The woolly elm aphid, *Eriosoma americana* Riley, rolls or curls one side of the leaf of American elm, forming a sort of pseudo-gall, as shown in Figure 57. Inside the roll, or deformed leaf, are the woolly aphids. The summer generations inhabit the roots of *Amelanchier*. *Eriosoma ulmi* Linn. on European elm makes the same type of leaf roll as formed by *E. americana* on American elm. The summer generations occur on the roots of *Ribes* (currants and gooseberries). Both species are found in Connecticut.

The woolly apple aphid, *Eriosoma lanigera* Hausm., places its overwintering eggs on the elm, and the stem female hatching from one of

these eggs starts the leaf deformation known as rosette or leaf cluster of the American elm. Later, certain generations migrate to apple, pear and hawthorn, where the bluish-white, woolly aphids may be found in late summer on the twigs and in the margins of wounds and cankers on the trunk and branches. Swellings are often formed by this species on the twigs and also on the roots of apple.

Eriosoma lanuginosa Hartig deforms the leaf into a pouch gall and specimens collected in Stamford a few years ago seem to belong to this species.

FIGURE 57. Pseudo-gall of the woolly elm aphid. Natural size.

The woolly elm bark aphid, *Eriosoma rileyi* Thomas, congregates in flocculent masses on the bark and particularly around pruning scars. Apparently no other host plant is known.

Control. All of these woolly aphids on elm can probably be controlled by the addition of nicotine sulfate solution to the general lead arsenate spray.

Elm Lacebug

Corythucha ulmi Osb. & Dr.

This insect belongs to the family Tingidae, commonly called lacebugs on account of the bizarre patterns and transparent character of wings and projections from head and thorax. The elm lacebug is about one-eighth of an inch in length and sucks the sap from the under side of the leaves where large numbers sometimes occur. The base of each wing and the rear margin of the apex are dusky clouded. Several times the

Station has received this insect on elm, chiefly from points in Litchfield County at the higher elevations. (Figure 58).

Control. Although adult lacebugs of some species are resistant to nicotine sulfate sprays, probably the nymphs are less so, and it is doubtful if infestations are sufficiently severe to demand special treatment. If so, perhaps one of the white summer oils will prove satisfactory if the manufacturer's directions are followed.

FIGURE 58. The elm lacebug. Ten times enlarged.

FIGURE 59. The oyster-shell scale. Natural size.

Oyster-Shell Scale

Lepidosaphes ulmi Linn.

This is one of the most common insects on the bark of a large number of species of deciduous fruit, shade and woodland trees, as well as on ornamental shrubs. It is so abundant on ash, poplar, willow, birch, dogwood, butternut and lilac, that branches and small trees are often killed. It also infests apple, pear, elm and many other trees. The shell, or scale, of the female is from one-tenth to one-eighth of an inch in length. It is narrow at the anterior end with yellow or yellowish-brown exuviae, broad at posterior end, brown or gray, and about the same color as the bark on which it rests. Some of the scales are irregularly curved and the surface is smooth and more or less shiny. The male scale is similar to that of the female but is smaller. (Figure 59).

There is one annual generation and the winter is passed in the form of oval white eggs under the female scales. These eggs are formed in October and hatch the last few days of May. The tiny yellow crawlers are present for a few days on the bark. Then they settle and suck the sap and do not move afterwards. The shell or scale soon forms and increases in size as the insect becomes older and larger.

Control. A spray of nicotine sulfate solution about the first week in June will readily kill the newly hatched insects. After the scales have formed to protect them, such treatment is less effective.

Elm Scurfy Scale

Chionaspis americana Johnson.

This native scale, also called the white elm scale, closely resembles the scurfy scale, *Chionaspis furfura* Fitch. It usually occurs on the small twigs or sprouts of elm, but is not very common in Connecticut. The writers have seen sprouts five or six feet tall well covered, and it has been reported on the small twigs of large trees.

Scale of the female varies from one-twelfth to one-eighth of an inch in length, and is white, gray or sometimes yellowish, but often blackened by sooty mold. When removed from the bark, a conspicuous white mark remains. There are two annual generations in Ohio, and the insect passes the winter in the form of oval, purple eggs. These eggs probably hatch sometime in May.

Control. A spray of nicotine sulfate solution in early June will probably kill the young.

Elm Aspidiotus

Aspidiotus ulmi Johnson.

This native scale is circular, dirty white or buff, and less than one-twelfth of an inch in diameter. It occurs in Connecticut on the trunks and larger branches of the American elm, particularly on the smoother and thinner bark between and often under the edges of the plates of the thick outer bark. Little is known of its life history.

Control. Probably control measures are not needed, but if sprays of nicotine sulfate solution are applied against other insects, surely the young of this scale will be killed.

European Fruit Lecanium

Lecanium corni Bouché.

This European soft scale is very common throughout Connecticut. Although it is called the European fruit lecanium because of its habit of infesting peach, plum and pear, it also attacks a large number of different hosts, including ash, chestnut, elm, linden and maple. It is oval, light or dark brown, strongly convex and smooth and shiny. Often the scales are so closely packed together that the twig is encircled by them for several inches in length, and in such cases considerable injury results. There is only one annual generation and the winter is passed in a partially grown condition. The eggs are formed under the female scales, and hatch about July 1. (Figure 60).

Control. This scale will be controlled by a spray of nicotine sulfate solution in early July.

European Elm Scale

Gossyparia spuria Modeer.

This European unarmored scale is fairly common on elm, particularly on young trees in nurseries. In a few cases in Connecticut it has infested and injured the lower branches on street trees between one foot and two feet in trunk diameter. As a rule the scales settle in the crevices of the bark and are quite conspicuous because of their reddish or purplish brown color and fringe of white, cottony, wax secretion around the margin. The female is oval and about one-tenth of an inch in length. (Figure 61).

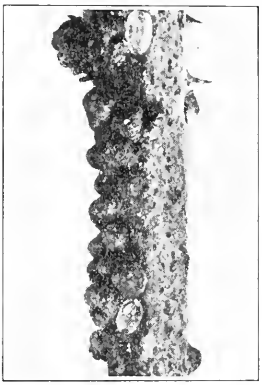

FIGURE 60. The European fruit lecanium, on raspberry. Natural size.

FIGURE 61. The European elm scale. Natural size.

The young are born alive about the middle of June in Connecticut. At first they settle on the under sides of the leaves along the veins, but later they return to the crevices of the bark of trunk and larger branches.

Control. This insect may be controlled easily either on leaves or bark by a spray of nicotine sulfate solution.

Buffalo Tree Hopper

Ceresa bubalus Fabr.

This insect is a green, triangular tree hopper with sharp dorsal ridge and sharp pointed lateral projections on the thorax, and is from one-fourth to three-eighths of an inch in length. It feeds chiefly by sucking the sap from the stems and leaves of sweet clover, joe-pye weed and other

succulent plants, and probably to some extent from trees. However, the females go to trees in September, particularly to elm and apple, and lay eggs in crescent-shaped slits in twigs of two or three years' growth. The egg slits are placed so closely together that sometimes the twigs are badly

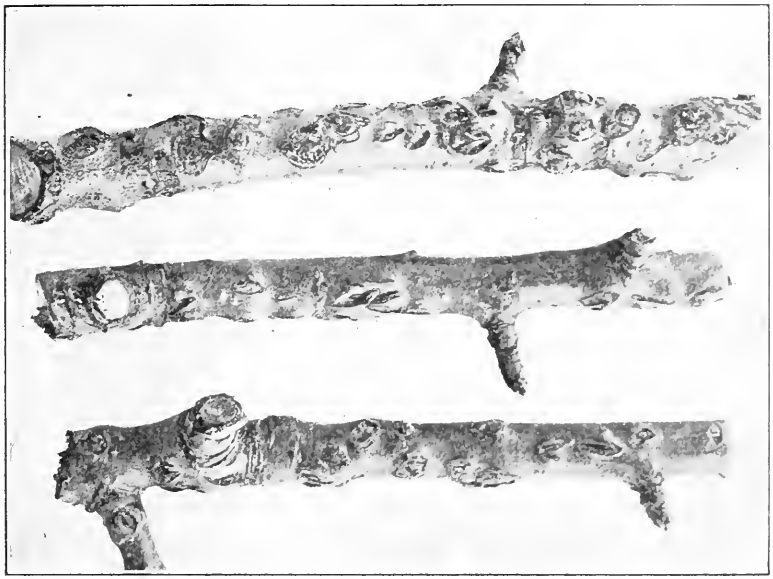

FIGURE 62. Scars made by the buffalo tree hopper in laying eggs. On apple. Natural size.

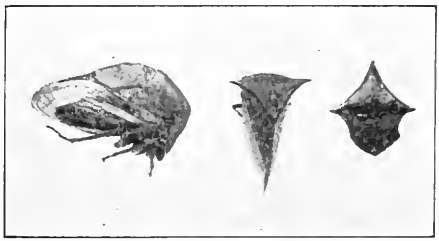

FIGURE 63. Buffalo tree hoppers. Twice natural size.

scarred, fail to heal and may become infected with injurious fungi. Figure 62 shows the egg scars and Figure 63 shows the appearance of the buffalo tree hopper.

Control. This insect cannot well be controlled by sprays, but the usual recommendations are to cut off and burn the twigs showing fresh egg-scars, and to cut and burn the weed areas around the trees in June.

Other Sucking Insects

Probably there are other aphids, tree hoppers and scales, as well as leafhoppers and leaf mites, that will occasionally be noticed on elm. The hickory lecanium, *Lecanium caryae* Fitch, occurs on elm twigs.

At least one species of mite, *Eriophyes ulmi* Gar., forms galls on elm leaves. Perhaps there are several or many species.

The European red mite, *Paratetranychus pilosus* C. & F., that injures fruit trees, also infests elm trees, although perhaps it may not cause serious injury.

The common red spider, *Tetranychus bimaculatus* Harvey*, infests the leaves of elm, occasionally causing severe injury.

Control. Probably these organisms will not seriously injure the trees and may be taken care of by the applications suggested for the control of the insect pests. In special cases it may be necessary to apply summer oil preparations, which are effective for the control of mites, and dilute lime sulfur (1 to 50 or 1 to 75) has also been used.

BARK BEETLES AND BORERS

Small European Elm Bark Beetle

Scolytus multistriatus Marsh.

The small European elm bark beetle was first noticed in the United States in Cambridge, Mass., in 1909, infesting several living elms. The insect was undoubtedly brought into Boston from Europe at some previous date. Since then this beetle has been discovered elsewhere in northeastern United States, and the nature of its distribution indicates that it has been introduced from Europe through several seaports. In Connecticut the insect is much more common in the southwestern part of the state than in the eastern part, and it appears probable that it has spread into Connecticut from the vicinity of New York City.

Although this insect has long been known as a pest of elms and will attack living trees, it breeds in trees in a weakened condition and does not seriously injure those that are growing vigorously. It was only after the Dutch elm disease was discovered, and the beetle was found to be a transmitter of this disease to healthy trees, that the serious nature of the infestation became apparent. Up to the present time this is the only insect in America which has been proven a carrier of the disease from infected to uninfected healthy trees. This does not mean that other insects may not later be found involved. The breeding and feeding habits of this species make it an ideal carrier. In the absence of the fungous disease the beetle itself cannot be considered a serious pest.

The adults are from two to three millimeters long and have a black thorax and reddish brown wing covers. They are most easily distinguished from other beetles infesting elm by the size and the structure of the abdomen. The apex of the abdomen appears truncated and on the second

*Called *telarius* Linn. by some authors.

ventral abdominal segment there is a posteriorly directed, conspicuous blunt process. The adult feeding and breeding tunnels are also quite distinct. After emerging from the tree in the spring, during the first part of May, the beetles fly to healthy trees and feed on the inner bark of the twigs. Flight does not appear to be extensive, simply to the nearest available trees for feeding and oviposition. The beetles bore into the twig in the angle of a fork or at the junction of a leaf petiole and make a short tunnel under the bark. When the wound thus caused heals, a crescentic scar results which is quite characteristic. After feeding a week or 10 days, the beetle leaves this part of the tree and flies to a weakened branch of the same or another tree, in which the brood gallery is formed. The Dutch elm disease fungus is inoculated into the healthy trees during the feeding period.

The brood tunnel formed under the bark of weakened elm branches is characteristic of this species. The direction of the tunnel is vertical, that is, with the grain of the wood. Eggs are laid in small niches along the sides of this tunnel. The small, white, footless larvae, or grubs, bore out at right angles to the adult tunnel, and the several larval tunnels

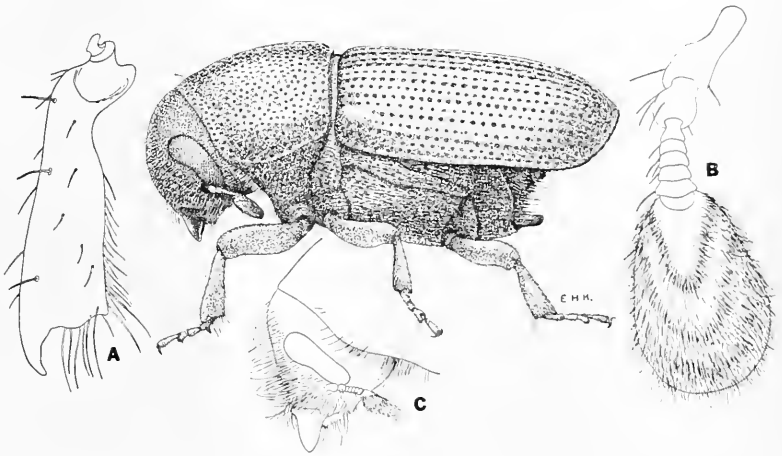

FIGURE 64. Small European elm bark beetle, female, lateral view, about 23 times enlarged. A, left fore tibia, posterior aspect: B, left antenna, lateral aspect; both enlarged about 76 times: C, head of male, lateral aspect, enlarged about 23 times.

diverge from one another as the larvae develop, so that ultimately those larval tunnels, starting from the extremities of the adult tunnel, often run with the grain of the wood. Adult and larval tunnels are in both the outer wood and the inner bark. The adult tunnel is usually from one to two inches long and the larval tunnels may be up to eight inches in length, although usually very much shorter. It is the girdling effect of the larval tunnels which kills the trees. When the larvae become fully grown, they pupate in cells in the bark, and the adults which develop from these pupae bore out through circular shaped holes. The presence of these latter give a "shot-holed" appearance to the bark of trees which have been infested.

The insect probably has two generations a year in Connecticut. The adults of the first generation appear in May and those of the second generation the last of the summer. We have found adults, eggs and young larvae in late August and early September. Hibernation occurs in the larval stage. This beetle is shown in Figure 64.

Control. In view of the relation of this insect to the transmission of the Dutch elm disease, its control becomes a matter of great importance. A reduction in the beetle population means a less rapid dissemination of the disease throughout the state. The insect breeds in weakened trees or trees that have been dead but a short time. In order to control this insect, three steps are necessary: (1) the destruction of the beetles wherever possible; (2) the elimination of all trees or parts of trees which are dead or dying and in which beetles might breed; (3) the maintenance of elms in a vigorously growing condition so that they do not become susceptible to attack.

All trees or parts of trees containing beetles in any stage of development should be cut down and burned. If a tree or branch is dead or weakened beyond hope of recovery, even though no beetles are present, the same treatment should be applied. In many instances this simply means the judicious pruning of elms, something that should be a normal procedure in the care of trees. In order to prevent trees from becoming weakened and hence susceptible to bark beetle attack, they should be protected from root and foliage injury and should be grown under proper conditions of soil moisture and fertility. The most common form of injury to which elms are susceptible is defoliation by leaf eating insects. Protection against these pests is described in another part of this bulletin.

Dark Native Elm Bark Beetle

Hylurgopinus rufipes Eich.

The dark native elm bark beetle is an American insect which occurs throughout northeastern United States and southeastern Canada wherever elm trees grow. It is by no means injurious to healthy trees, as it attacks only those that are dead or in a badly weakened condition. This insect would be of no importance as a pest were it not for the possibility that it may transmit the Dutch elm disease. Little is known about its food habits, and it very probably does not feed on healthy trees, as does the European elm bark beetle, before it makes the brood tunnel. This insect has been found in trees infected with the elm disease fungus and has transmitted the disease to cut elm branches in the laboratory. Under natural field conditions the beetle might transmit the fungus from one decadent tree to another and thus maintain a reservoir of the disease, even though no healthy trees were directly attacked.

The adult beetle is dark brown in color, two to three millimeters long, and has longitudinal grooves in the wing covers. It may be readily distinguished from the European elm bark beetle by its darker wing covers, and by the structure of the abdomen. In this native American species the posterior end of the abdomen is not truncated and does not bear the posteriorly directed, blunt protuberance characteristic of the European species.

The brood tunnels in elm are also different from those of the European species in that they run in a generally horizontal direction, that is, across the grain of the wood. The larval tunnels tend to run vertically. When crowded conditions prevail in an elm branch or trunk, however, and the tunnels are consequently abundant and close together, they may run in all directions, so this criterion does not always hold good. The larvae are small, white, footless grubs similar in appearance to other bark beetle larvae.

The adults emerge from the bark of elm in late spring and attack decadent elms. The methods of forming tunnels and laying eggs are similar to those of most bark beetles. The tunnels groove both inner bark and outer wood, although this species does not groove the wood as deeply as does the small European bark beetle. The second brood of beetles emerges in late summer and early fall. There is some evidence that adults

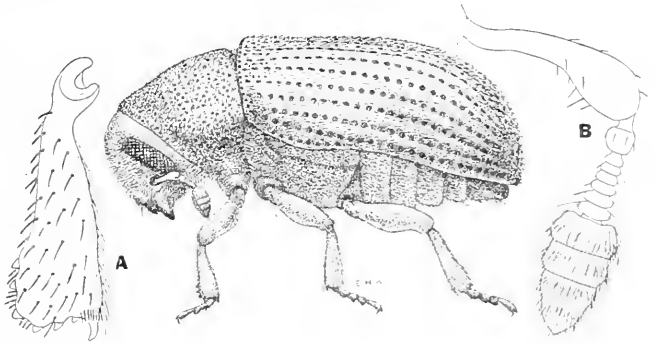

FIGURE 65. Dark native elm bark beetle, lateral view, enlarged about 23 times. A, left fore tibia, posterior aspect; B, left antenna, lateral aspect; both enlarged about 76 times.

may hibernate in the bark of elms and larvae are commonly found in elms during the winter. This beetle is shown in Figure 65.

Control. The control of this insect consists of the removal and burning of dead and dying elm branches and trees during the winter when the larvae are present. If the adults hibernate extensively in holes in the bark of healthy trees, then this method would be less efficient than would be the case did hibernation occur in the larval stages only.

Elm Bark Weevils

Magdalis sp.

There are two species of weevils—the black elm bark weevil, *Magdalis barbita* Say, and the red elm bark weevil, *M. armicollis* Say—which commonly infest elms in this part of the country. Both are snout beetles of the same size, about one-fourth inch long, and their life cycles and habits are similar. The immature stages are alike in general appearance, being footless, small white grubs, but the adults may be distinguished by their color.

The adult weevils emerge through small round holes in the bark of infested trees late in May and early in June. They feed to a limited extent on the foliage. This is not a serious matter, however. The larvae bore tunnels under the bark, scoring both the inner bark and outer wood. Their tunnels frequently, but not always, run in the direction of the grain of the wood and are about one and one-half inches long. The pupae are found in oval cells under the bark in May.

These weevils confine their activities largely to the branches of elm trees. Although they have been considered serious pests, it appears that they preferably attack branches weakened from some other cause. At times they are very abundant.

Control. Control measures are the same as those suggested for the elm borer. Elms that are sprayed for the control of other insects may possibly be protected somewhat from infestation by these weevils, but there is little direct evidence for this.

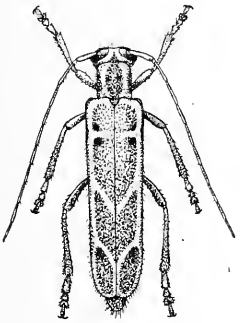

FIGURE 66. The common elm borer. Twice natural size.

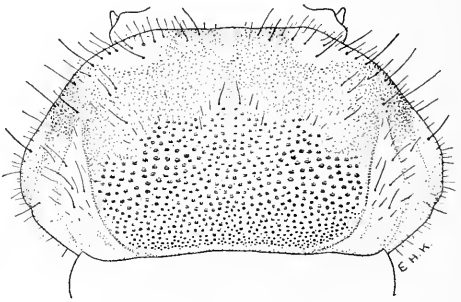

FIGURE 67. Thorax of larva of common elm borer. About eight times natural size.

Common Elm Borer

Saperda tridentata Olivier.

This is one of the commonest borers found under the bark of elm trees. The adult beetle is about one-half inch long and gray in ground color with light red marks and black dots on the wing covers and prothorax. The size, color and shape (Figure 66), together with the long antennae, readily distinguish it from other beetles infesting elm.

The larva is slightly over an inch long when fully grown, white in body color with a yellowish brown head, footless, and larger at the anterior than at the posterior end. (Figures 67 and 68).

Adults begin to emerge from the trees about the middle of May and emergence continues for some time thereafter. The beetles continue in flight throughout most of the summer. During this period some feeding has been reported on the under sides of the leaves, particularly along the midrib, but this is probably not extensive. The eggs are laid on the bark, either singly or in small groups.

The larvae bore in the cambium layer and, in later developmental stages, to some extent in the sapwood. The larval tunnels, which score both

the inner bark and outer wood, are tortuous and filled with brown frass. These tunnels are narrow at first but widen as the larvae grow. (Figure 68). In the spring of the year a pupal cell is excavated under the bark and here the insect transforms into the adult stage. The adult bores an exit hole through the bark. The total life cycle takes at least one year for completion, and possibly two or three. During the winter months, larvae of all sizes may be found under the bark of infested trees.

The common elm borer may girdle branches and the trunk of an elm and cause its death. When the larvae are abundant, the bark frequently becomes loose in large patches. It is questionable, however, whether the insect is a pest of vigorous, healthy trees. It prefers those which are weakened or dying from some other cause. Many elms growing along

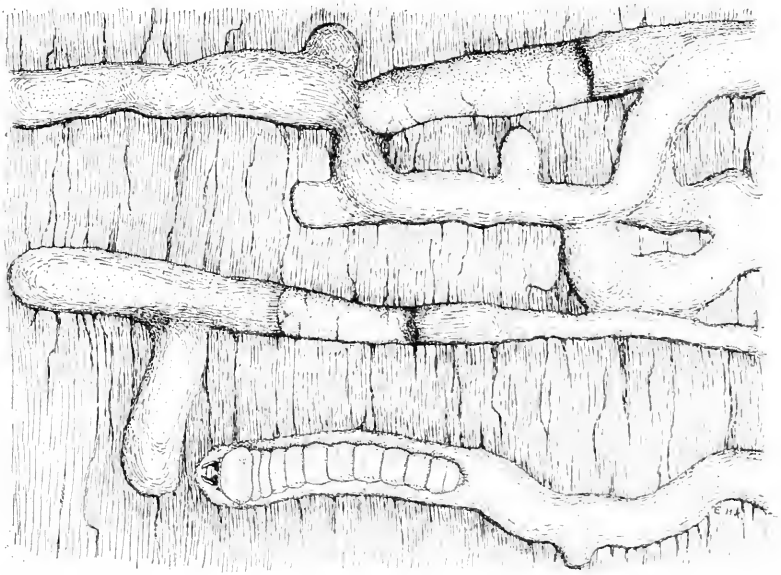

FIGURE 68. Larva and galleries of the common elm borer. Slightly enlarged.

streets and in towns are in poor condition due to root injury, lack of water, and the like, and are hence susceptible to attack. Defoliation by leaf eating insects and changes of the water level in swamps also weaken or kill elms, and the borer may be found in such trees.

Control. The control of this insect is more a matter of prevention than cure. Indications of attack on living trees, such as thin foliage, wilting and premature yellowing of the leaves, can be noted as a rule only after it is too late to save the tree or the part of a tree affected. If trees are kept in a healthy condition they should not be susceptible to attack. Cutting off and burning the infested parts of the trees while the larvae are still present, that is, during the winter and early spring, tends to reduce the numbers of adults which will occur later in the season.

Leopard Moth

Zeuzera pyrina Linne.

The leopard moth is probably the most serious borer in elms in Connecticut. It also infests several other trees and shrubs. The indications of attack are very conspicuous. Small twigs break over and wilt, leaves on large branches turn yellow and drop prematurely, and dead branches become abundant in the tops of large trees. Excessive sprouting sometimes occurs below the dead limbs. Sometimes branches two or three inches thick are so weakened that they break off during a storm. (Figure 69).

This insect is native to Europe and Asia and was first found in the United States in 1879. It was reported to be present in Connecticut in

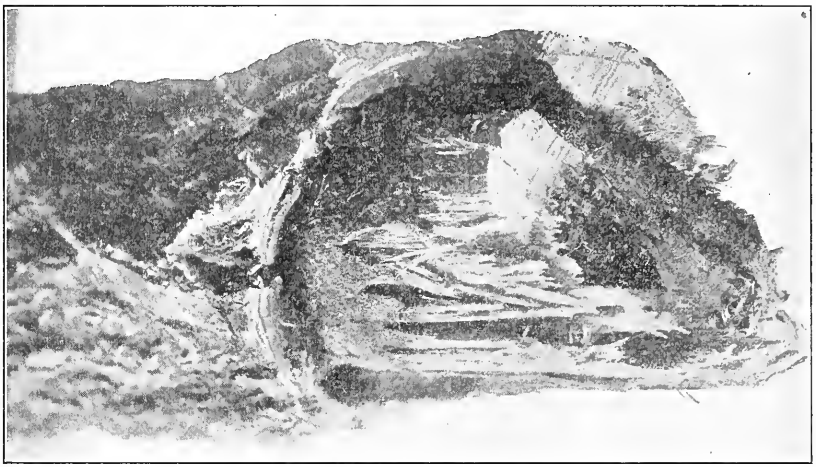

FIGURE 69. Broken elm branch showing tunnel made by the larva of the leopard moth.

1894, and between 1900 and 1910 was responsible for the failure and removal of many large elm trees in the coastal towns and cities. It has never been so destructive in the inland regions of the state. At the present time it is found in New Jersey and northward along the coast to northeastern Massachusetts.

The adult moth has white wings bearing metallic blue dots, a yellowish anterior margin and yellowish streaks along the principal veins. The thorax is white or yellow on the upper side with six blue-black spots. The abdomen is black with more or less whitish pubescence. The female has a wing spread of from two and one-half to three inches. It is much more conspicuously marked than the male and much larger, the wing expanse of the latter being about one and three-fourths inches. (Figure 70). The larva is a white caterpillar conspicuously marked with black dots and two inches or more in length when fully grown. The thoracic shield, at the anterior end of the body, and the anal shield, at the posterior end, are dark brown to black in color. (Figure 71).

The adult moths are in flight during the entire summer but are more abundant in July than at other times. The female does not appear to fly far, remaining in the same tree where it passed the pupal stage, or in an adjacent tree. The eggs are laid singly or in small groups in crevices in the bark, usually in the upper part of the tree. They may, however, be laid in the trunks of small trees. The eggs hatch in about 10 days. The young larvae usually crawl to the smaller branches before boring in, but they have been found entering branches two to five inches in diameter. In small branches and twigs the larvae often hollow out all but the bark. In larger branches the burrows are in the outer wood and often irregular areas are eaten away just under the bark. If a branch becomes too small for the growing larva, or dies, it is vacated and the larva crawls away on

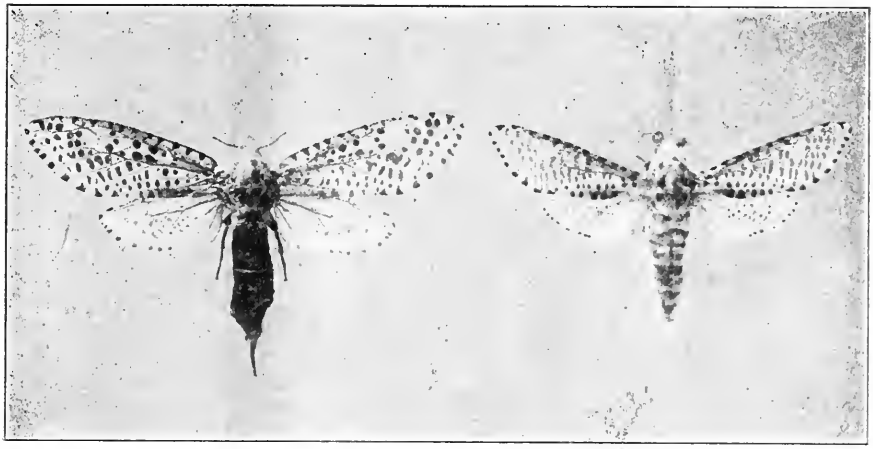

FIGURE 70. Female and male leopard moths. Natural size.

the surface to a more favorable location, where it enters. The opening of the tunnel is kept covered with a gray web. The tunnel is kept clear of frass, and every time frass is thrown out the web is broken, to be re-formed immediately after. One of the indications of the presence of this borer is discharged pellets of frass on the ground under the trees. During the latter part of October the larva, which is about an inch long, bores an inch or two into the wood and hibernates there.

During the next summer the boring is continued in the same manner, but more extensively, and the resulting injury is more severe. Branches four to eight inches in diameter and the trunks of small trees may be completely girdled and large areas under the bark eaten away. The larvae hibernate the second winter and resume feeding for a short time in the spring. In May, or later, pupation occurs under the bark. Before pupating, the larva bores almost through the bark, then retreats a short distance and forms an oval chamber in which the pupa is found. Just before the adult emerges, the pupa wriggles out of the tunnel just mentioned, breaking through the thin layer of bark, and projects partly out of the hole. The adult then breaks out of the pupal skin.

This insect is a pest of healthy, vigorous trees, severely injuring them, but does not appear able to survive in dead wood. It is most abundant, however, in cities and towns and is not common in the country districts. Its scarcity in these latter regions has been attributed to the activities of insectivorous birds. Parasites of the leopard moth are relatively rare.

Control. The habits of the insect make it difficult to control. Heavily infested trees should be cut down and destroyed. Infested branches should be cut off well below the lowest infested point. In many cases the burrows of larger larvae can be detected and the larvae killed by injecting some fumigant, as carbon disulfide, or by using a hooked wire to pull them out.

FIGURE 71. Larva of the leopard moth in its tunnel in elm. Natural size.

Twig Girdlers

Oberea tripunctata Swederus and *Oncideres cingulatus* Say.

There are two twig girdlers that infest elm, one of which, *Oberea tripunctata* Swed., is known as the elm twig girdler, and the other, *Oncideres cingulatus* Say, as simply the twig girdler. Both species attack several kinds of trees and shrubs besides elm, but the former has been reported particularly abundant on this tree in some parts of the United States. The adults of these two beetles have the peculiar habit of cutting grooves, or girdles, around the elm twigs on which eggs are laid. Even though such

twigs may break off, the injury differs from that of the twig pruner (page 307), as it is the larvae of the latter which cut off the small branches.

The adult of the elm twig girdler (*O. tripunctata*) is a beetle about three-fourths of an inch long, slender in shape, and with long antennae. The thorax is yellow with three black dots, and the wing covers are gray with a relatively broad, whitish, longitudinal stripe on each. The adult of the twig girdler (*O. cingulatus*) is about the same length as that of the above insect, but more robust in form and of a different color. The general body color is gray with one brownish band across the anterior ends of the wing covers and another across the posterior ends. The larvae of both species are white, cylindrical grubs about three-fourths of an inch to one inch long when fully grown.

The adults of the elm twig girdler emerge during the latter part of May and the first part of June and are active until the middle of July. They feed to some extent on the leaf veins and young twigs. The female cuts a groove around a twig near the tip so that sooner or later the twig breaks off at this point. A second groove is cut a few inches below the first. Two parallel longitudinal slits are then made between the grooves, and an egg is laid in an incision at the proximal end of these slits or under the edge of one of the slits itself. The egg hatches in a week or 10 days and the larva tunnels in the twig. Holes to the exterior are made at intervals along the tunnel and through these frass is extruded. The presence of the larva is indicated by this characteristic and by the wilted appearance of infested twigs in the summer. The larva pupates in the tunnel in May the second year after the egg is laid. The pupal stage is two or three weeks in length. The total life cycle is completed in two years.

The flight season of adults of *Oncideres cingulatus* occurs during the last of August and the first of September. The female girdles twigs one-half inch or less in diameter and lays its egg, one or more in a twig, above the girdle. The larvae usually hatch before winter and fall to the ground in the twig when the latter breaks off. They become fully grown about the middle of the following July. Pupation occurs at one end of the larval tunnel.

Control. The control of *Oberea tripunctata* on low trees and shrubs may be effected by cutting off and destroying the infested twigs while the larvae are still present, any time of the year except June and July. Since the adults feed on the foliage and young growth to some extent, spraying with lead arsenate the last of May might be somewhat beneficial. Control measures against *Oncideres cingulatus* consist of gathering and burning the fallen twigs which contain the larvae and eggs.

Pigeon Tremex

Tremex columba Linn.

The pigeon tremex is a large wood-wasp which attacks weakened and dying trees only. The adult female is one to one and one-half inches long and has a wing spread of about two and one-half inches. It may be easily recognized by the dark yellow head and thorax, the yellow marks on the sides of the black abdomen, and the ovipositor at the tip of the abdomen.

(Figure 72). This ovipositor is stout and projects about one-fourth of an inch. It is used to insert the eggs into the tree when they are laid. The male is about two-thirds as large as the female, without an ovipositor, darker in color, and the marks on its abdomen are inconspicuous. The larva is a white cylindrical grub with a prominent pointed "horn" at the tip of the abdomen.

The adults are active during the summer and lay their eggs in weakened trees. The larva bores in the wood, making a cylindrical tunnel, and pupates in the tunnel. The adult emerges through a hole about the diameter of a common lead pencil. The larvae of this insect are rather extensively parasitized by a large ichneumon, *Thalessa lunator* Fabr., which has an ovipositor three or four inches long.

Control. Infestation by the pigeon tremex is a certain indication of decadence, and the tree or branch infested has usually been weakened be-

FIGURE 72. The pigeon tremex.
Natural size.

yond recovery and should be removed. Healthy trees are not attacked. This insect is not a serious pest.

Banded and Red Hardwood Borers

Neoclytus capraea Say, and *Neoclytus acuminatus* Fabr.

The larvae of these two long-horned borers are very commonly found in hardwood logs and cordwood cut from many species of trees. *Neoclytus capraea,* the banded ash borer, is reported to be destructive to living ash in some parts of the United States, but it is questionable if either species is a pest of healthy trees. It is as destroyers of sound wood that they are injurious.

The adult of *Neoclytus capraea* is a dark purple beetle about one-half inch long with four yellow bands on the wing covers. The two anterior bands are connected by a median longitudinal yellow stripe. The adult of *N. acuminatus* is a reddish beetle about three-eighths of an inch long and has three yellow bands on the wing covers. The larvae are white cylindrical grubs which have the abdomen constricted slightly near the posterior end.

Both species are typically wood borers which mine very little under the bark. Their tunnels in the wood are packed with frass. The adults are active during the latter part of the spring and the first part of the summer.

Control. Since neither beetle is a pest of living elms in Connecticut, no particular attention need be given to control measures.

Occasional Borers in Elms

Several insects are occasionally found boring in the bark or wood of living and dead elms. Some of these are discussed briefly here, none of them being serious pests of this tree as a rule. Unless they occur in great abundance, no control measures are necessary.

The elm bark borer, *Physocnemum brevilineum* Say, mines the outer bark of living elms, a rather uncommon habit for beetles of this group. The adult is about one-half inch long with a dark blue-black head and thorax and purplish wing covers. Near the middle of each wing cover is a white mark. The femora are distinctly swollen.

Several flat-headed borers of the family Buprestidae occur in elm, making their larval tunnels under the bark and to some extent in the wood. The larvae of this group have the anterior end of the body, just behind the head, conspicuously widened and flattened. *Dicerca divaricata* Say, *Buprestis rufipes* Olivier, *Anthaxia viridifrons* Gory, *Anthaxia viridicornis* Say, and *Chrysobothris femorata* Olivier have all been reported as infesting elms. The adults and larvae of these species differ in size.

The bark beetle, *Scolytus sulcatus* Leconte, a species half again as long as *Scolytus multistriatus* and darker in color, has recently been found in elm trees. This is not a very common insect but may be of importance in regard to the transmission of the Dutch elm disease.

Ambrosia beetles bore into dying elm trees and stumps which have not dried out. The tunnels are made by adults and extend a short distance into the wood. The larvae feed on a fungus which grows in the tunnels. *Xyloterinus politus* Say has been found in elm, and it is possible that other species will infest this host.

The twig pruner, *Hypermallus villosus* Fabr., occurs on elms but is more common on oak, maple and hickory. The larvae bore in small branches one inch or less in diameter, and these branches, with larvae inside them, drop off the trees in late summer and early fall. The fallen branches may be gathered and burned in order to reduce the abundance of the insect.

Carpenter ants, *Camponotus herculeanus* var. *pennsylvanicus* DeGeer, and termites, *Reticulitermes flavipes* Kollar, make tunnels in the solid wood of many trees, including elms. The carpenter ants are black and have the anterior part of the abdomen constricted. The worker caste of termites is white and without the constriction in the abdomen. Infested trunks of trees can be fumigated with good results.

Mites (Acarina) are very common under the bark of decadent elms. Several species occur, some feeding on organic debris, fungi, and the like, and some parasitic on insects. Frequently they are found attached to the bodies of beetles which infest elm trees. Their importance in the transmission of the Dutch elm disease is a matter of conjecture. None of the bark-inhabiting species affect the health of the tree.